and an oxidizer and heating the high-k dielectric layer to a temperature greater than 700°C while the gate dielectric layer is in the ambient, the ambient mitigating the formation of lower dielectric constant (lower-k) material between the high-k gate dielectric layer and the substrate. Ma teaches the formation of a Zr-Al-O high-k dielectric layer including an anneal step. Ma teaches the anneal step as occurring at a temperature between 400°C and 800°C in "an atmosphere including elements selected from the group consisting of Ar, N_2, N_2:H_2 forming gas, O_2, H_2O, N_2O, NO, no gas, and oxygen plasma." (Col. 7, lines 18-21.) While hydrogen, nitrogen, and oxidizers are included in the laundry list of gases, there is no guidance in Ma for choosing among the list an ambient that combines hydrogen, nitrogen and oxidizer so as to mitigate the formation of lower dielectric constant (lower-k) material between the high-k gate dielectric layer and the substrate. This would amount to looking for a needle in the haystack without guidance as to the characteristics of the needle you are looking for.

Ma does teach that oxygen is typically used if the metal is formed by evaporation (e.g., Zr-Al) and oxygen needs to be added to form the dielectric. In Col. 6, lines 13-26, Ma further teaches annealing in an inert and/or oxidizing ambient. While this implies that some combination may be used, it does not suggest the specific combination of hydrogen, nitrogen, and oxidizer as claimed. While N_2:H_2 may be selected by chance, there is no guidance for choosing N_2:H_2 over the other listed inert gases Ar or N2. Furthermore, the hydrogen and nitrogen of the claimed invention are not inert. As described on page 12 lines 8-19, nitrogen can be introduced to the dielectric and hydrogen can react with unwanted impurities and act as a passivant. Nitrogen and hydrogen also allow the temperature of the anneal to be increased. Furthermore, the inclusion of hydrogen prevents or reduces the growth of interfacial lower-k dielectric materials. (Page 13, lines 13-19.) Ma teaches to use an inert and/or oxidizing ambient and since the hydrogen and nitrogen of the claimed invention are not inert (in terms of the claim limitation mitigating the formation of lower-k material between the high-k gate dielectric layer and the substrate), Ma does not anticipate the claimed invention. Accordingly, Applicant respectfully submits that claim 1 is unanticipated by Ma.

PAGE 3/7 * RCVD AT 3/30/2005 12:35:23 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-1/0 * DNIS:8729306 * CSID:972 278 9775 * DURATION (mm-ss):03-02

Applicant respectfully submits that claims 10 and 16 are similarly unanticipated by Ma.

The Examiner rejected claims 2-9, 11-15, and 17-21 under 35 U.S.C. § 103(a) as being unpatentable over Ma et al. in view of Park (2001/0006843 A1).

Applicant respectfully submits that dependent claims 2-9 are patentable over Ma in view of Park as there is no disclosure or suggestion in the references of introducing an ambient comprising hydrogen, nitrogen and an oxidizer and heating the high-k dielectric layer to a temperature greater than 700°C while the gate dielectric layer is in the ambient, the ambient mitigating the formation of lower dielectric constant (lower-k) material between the high-k gate dielectric layer and the substrate, as required by claim 1 from which these claims depend. As discussed above relative to claim 1, Ma does not disclose or suggest annealing in an ambient comprising hydrogen, nitrogen and an oxidizer such that the ambient mitigates the formation of lower dielectric constant material between the high-k gate dielectric layer and the substrate. Park is added by the Examiner to teach the equivalence of NH_3 and N_2:H_2 forming gas.

Applicant respectfully submits that claims 11-15 and 17-21 are similarly patentable over the references.

Applicant respectfully submits that claims 4, 13, 19, and 6, 15, 21 are further patentable over the references as there is no disclosure or suggestion for maintaining a pressure of about 200 Torr (claims 4, 13, and 19) or 20 Torr (claims 6, 15, and 21). The Examiner argues that it would have been obvious to maintain the pressure as claimed since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. However, the claimed pressures amount to more than an optimum value. They help achieve a specific result: avoiding significant oxidization of the substrate to dielectric interface (see, page 13, lines 19-26). This desired result is not addressed by the anneal conditions in the cited art. Accordingly,

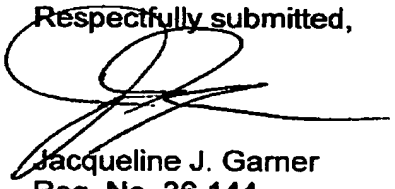
PAGE 4/7 * RCVD AT 3/30/2005 12:35:23 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-1/0 * DNIS:8729306 * CSID:972 278 9775 * DURATION (mm-ss):03-02

Applicant respectfully submits that claims 4, 13, 19, 6, 15, and 21 are further patentable over the references.

Applicant respectfully submits that claim 7 is further patentable over the references as there is no disclosure or suggestion in the references of initially introducing ammonia followed by the oxidizer to mitigate the likelihood of crystallization of the high-k material. Ma teaches the addition of Al or other trivalent metal to prevent crystallization of the high-k dielectric. Ma does not disclose or suggest specific anneal parameters to mitigate crystallization nor does Ma teach introducing ammonia or any hydrogen/nitrogen source followed by an oxidizer in an anneal step. Even if Ma is modify by replacing N_2:H_2 with NH_3 as taught in Park, there is no disclosure or suggestion of initially introducing ammonia followed by the oxidizer to mitigate the likelihood of crystallization of the high-k material. Accordingly, Applicant respectfully submits that claim 7 is further patentable over the references.

In light of the above, Applicant respectfully requests withdrawal of the Examiner's rejections and allowance of claims 1-21. If the Examiner has any questions or other correspondence regarding this application, Applicant requests that the Examiner contact Applicant's attorney at the below listed telephone number and address.

Respectfully submitted,



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PAGE 5/7 * RCVD AT 3/30/2005 12:35:23 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-1/0 * DNIS:8729306 * CSID:972 278 9775 * DURATION (mm-ss):03-02